EFFECTS ON FARM INCOMES AND RURAL LABOUR OF A RELATIVE INCREASE IN WAGES*

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We use the concept of the elasticity of farm incomes with respect to changes in input prices to analyse the effects of a large increase in relative wages on selected measures of farm incomes. In order to estimate the elasticity of farm incomes we have to estimate elasticities and cross-elasticities of demand and supply for farm labour and capital. The estimates of elasticity of demand for operator and hired labour allow us to calculate the impact of a rise in wages on numbers of farmers and hired labour employed in agriculture.

Introduction

There have been moves recently by the Australian trade union movement to have the statutory working week reduced from 40 hours to 35. According to *Hansard* [4] some Commonwealth, State and Local Government Departments and some mining and stevedoring industries already have a 35-hour week. An equivalent percentage across-the-board reduction allowed to agricultural industries would result in an effective increase in the unit cost of labour employed in agriculture of approximately 14 per cent, *ceteris paribus*. We are interested in the effects of such a large change in relative input prices on farm incomes and, ultimately, numbers employed in farming.

In this paper we make use of a theoretical model which describes the relationship between changes in farm incomes and changes in the prices of agricultural inputs. In particular, we look at the effect on selected income measures of a relative increase in wages. Net income, defined here as the return to management and risk, is an indicator of the incentive for operators to remain in farming. Changes in this net income, together with changes in the opportunity cost of operators' labour and capital (net farm income) which may follow an increase in wages, could be major determinants of the change in the number of operators remaining in farming.

Our model estimates the elasticity of net income with respect to changes in the per unit price of labour. We use the estimated elasticities of net income and demand for labour (hired and self-employed) to trace through the effects of the change in relative wages on numbers employed in agriculture. The input elasticities are estimated empirically by the use of simultaneous and single equation models of the demand for and supply of labour and capital in Australian agriculture.

The aggregate data utilized in the analyses mask what may be important distributional effects of a relative increase in wages; for

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example, the differential impact the shorter working week may have on the various agricultural industries and on the relative shares of labour and capital in total output. These aspects are only briefly examined in this paper. A further limitation which is discussed in the text is the partial equilibrium nature of the analysis.

The Model

The basic model is an expression of the elasticity of net income with respect to changes in the per unit price of labour. Net income is defined as:

$$N = PQ - wL - rK, \tag{1}$$

Where P = price of agricultural output,
Q = quantity of agricultural output,
w = wage rate for labour,
L = labour input,
r = per unit price of physical capital,
K = capital input.[1]

The mathematical derivation of the elasticity of net income (E_N) for the general two-input case is described below. It is a refinement of a model developed by Tweeten and Quance [16]. A deficiency of their model was that it did not allow for the possibility of input substitution when the price of one of the inputs changed. Tweeten and Quance defined net income as gross revenue minus only the costs of the input for which a price change was being examined. The present model takes account of input substitution via the inclusion of the last two terms in equation (8)[2].

To calculate E_N, equation (1) in the text is differentiated with respect to w while holding r constant and the result is multiplied by w/N:

$$E_N = (dN/dw)\, w/N = P\cdot w/N\,(\partial Q/\partial w) + Q\cdot w/N\,(\partial P/\partial w) - w^2/N\,(\partial L/\partial w) - w\cdot L/N - r\cdot w/N\,(\partial K/\partial w) \tag{2}$$

Taking each of the five terms in (2) separately we can write:

$$\begin{aligned} P\cdot w/N\,(\partial Q/\partial w) &= P\cdot Q/N\,(\partial Q\cdot L/\partial L\cdot Q)\,(\partial L\cdot w/\partial w\cdot L) \\ &\quad + P\cdot Q/N\,(\partial Q\cdot K/\partial K\cdot Q)\,(\partial K\cdot w/\partial w\cdot K) \\ &= R/N \cdot E_{P_L} \cdot E^d_{L/w} + R/N \cdot E_{P_K} \cdot E^d_{K/w} \end{aligned} \tag{3}$$

Where R = gross revenue (P·Q),
E_{P_L}, E_{P_K} = elasticities of production of inputs L and K respectively,
$E^d_{L/w}$ = elasticity of demand of L with respect to its own price w,
$E^d_{K/w}$ = cross elasticity of demand of K with respect to w.

The second term in (2) can be expanded to:

$$\begin{aligned} Q\cdot w/N\,(\partial P/\partial w) &= P\cdot Q/N\,(\partial Q\cdot L/\partial L\cdot Q)\,(\partial P\cdot Q/\partial Q\cdot P)\,(\partial L\cdot w/\partial w\cdot L) \\ &\quad + P\cdot Q/N\,(\partial Q\cdot K/\partial K\cdot Q)\,(\partial P\cdot Q/\partial Q\cdot P)\,(\partial K\cdot w/\partial w\cdot K) \end{aligned}$$

[1] We acknowledge the controversy over the use of the neoclassical models incorporating measures of capital services, i.e., the alleged impossibility of measuring aggregate capital independently of relative prices. However, we persist with such 'fantasies' in the belief that the results are useful. Because we regard the construct representing capital services as henceforth free of contamination by the price of capital we proceed to partial differentiation.

[2] For a fuller discussion of the problems in the Tweeten and Quance formulation see Ryan [14].

$$= \frac{R \cdot E_{P_L} \cdot E^d_{L/w}}{N \cdot \eta} + \frac{R \cdot E_{P_K} \cdot E^d_{K/w}}{N \cdot \eta} \tag{4}$$

where η = elasticity of demand for the product.
The third term in (2) expands as follows:

(5) $w^2/N\ (\partial L/\partial W) = w \cdot L/N\ (\partial L \cdot w/\partial w \cdot L) = w \cdot L/N\ E^d_{L/w}$

(6) The fourth term can be expressed as $w \cdot L/N$ and the last term as:

(7) $r \cdot W/N\ (\partial K/\partial w) = r \cdot K/N\ (\partial K \cdot w/\partial w \cdot K) = r \cdot K/N\ E^d_{K/w}$

Rewriting (2) in terms of equations (3) to (7) and rearranging we obtain:

$$\begin{aligned} E_N = {} & R/N E_{P_L} \cdot E^d_{L/w}(1 + 1/\eta) - w \cdot L/N\ (1 + E^d_{L/w}) \\ & - r \cdot K/N\ E^d_{K/w} + R/N\ E_{P_K} \cdot E^d_{K/w}(1 + 1/\eta). \end{aligned} \tag{8}$$

If we make the assumption the E_{P_L} and E_{P_K} in a Cobb-Douglas world equal their relative shares $w \cdot L/R$ and $r \cdot K/R$ respectively, (8) reduces to:[3]

$$E_N = w \cdot L/N\ \left(\frac{E^d_{L/w} - \eta}{\eta}\right) + r \cdot K/N\ \left(\frac{E^d_{K/w}}{\eta}\right). \tag{9}$$

Values for the terms in (9) can be obtained directly from aggregate agricultural statistics, except for the parameters $E^d_{L/w}$, $E^d_{K/w}$ and η.[4] To estimate $E^d_{L/w}$ and $E^d_{K/w}$ requires the specification and estimation of demand equations for labour and capital, and this is described in the following two sections.[5] In the absence of precise knowledge of the value of η for Australian agricultural production as a whole, reliance will be placed on sensitivity analyses of E_N with respect to η.

Single-Equation Estimation of Input-Demand Elasticities

In order to obtain values for $E^d_{L/w}$ and $E^d_{K/w}$ (and $E^d_{K/r}$ and $E^d_{L/r}$, the direct price elasticity of demand for non-human capital and the cross elasticity of demand for labour respectively) input-demand equations were

[3] Relaxation of the Cobb-Douglas assumption does not substantially affect the empirical estimates of E_N derived later.

[4] The adjusted values for aggregate Australian Net Farm Income as calculated by Glau [10] have been used as a starting point. We obtained values for N, the return to management and risk, by deducting from Glau's figure an opportunity cost for operators' labour, the average capital city basic wages for males and females, and a net interest figure being the opportunity cost of capital less interest paid on borrowed funds. To obtain values for wL in proportionate terms, we multiplied the labour share calculated in Young [20] by the value (1 — N/PQ). The values for rK were arrived at in similar fashion. However, we have taken the capital share to be both the capital share and the intermediate inputs share calculated in Young [20].

The gross value of farm production (PQ) was taken from the Commonwealth Bureau of Census and Statistics [3]; the information about numbers of working farm operators, male and female, is also from the Commonwealth Bureau of Census and Statistics [2].

[5] For a rigorous theoretical analysis of the relationship between own- and cross-price input demand functions see Ferguson [8]. Empirical studies of the demand for labour have been relatively common in the U.S. and U.K. Similar models to the ones outlined below which have been used in the U.S. can be found in Griliches [11], Schuh [15], Wallace and Hoover [19], Bauer [1], Tyrchniewicz and Schuh [18], Gardner [9] and Liainos [13]. In the U.K. there are the studies by Cowling and Metcalf [6, 7] and Tyler [17].

specified and estimated. These were of the simple *ad hoc* form with a homogeneity constraint imposed:

(10) $$ln\, D_L = A + E^d_{L/w}\, ln\,(w/P) + E^d_{L/r}\, ln\,(r/P) + u$$

(11) $$ln\, D_K = A' + E^d_{K/r}\, ln\,(r/P) + E^d_{K/w}\, ln\,(w/P) + u',$$

where D_L is the demand for labour and D_K is the demand for the services of all non-human capital, taken from Young [20] and Powell (private communication); r is the B.A.E. Prices Paid Index for Equipment and Supplies; w is the B.A.E. Wage Index; P is the B.A.E. Prices Received Index for All Products; and u and u′ are appropriate random error terms. The capital series is an index formed from the added values of Gross Fixed Capital Expenditure and intermediate materials used in agriculture.

The equations were also estimated with fixed-weight Fisher lags on the real price variables. The lags were of the following form:

(12) $$F(w/P)_t = \tfrac{1}{2}(w/P)_t + \tfrac{1}{3}(w/P)_{t-1} + \tfrac{1}{6}(w/P)_{t-2}$$

where $F(w/P)_t$ is the constructed variable used in the regression. Distributed lags of this form were chosen primarily because of the shortness of the data series (1948-9 to 1967-8). A time variable was also included in alternative estimations of equations (10) and (11).[6] Separate functions for total, operator and all hired labour were fitted.

Simultaneous-Equation Estimation of Input Demand Elasticities

An alternative estimation of $E^d_{L/w}$ and $E^d_{K/w}$ (and $E^d_{K/r}$ and $E^d_{L/r}$) was made by means of the specification and estimation of simultaneous models of supply and demand for labour and capital. The equations were specified in this form to overcome any simultaneous equation bias introduced in the single-equation models through ignoring such supply factors as population and unemployment.

(i) *The Labour Models*

The first of two models specified was as follows:

(13) $$ln\, D_L = A + E^d_{L/w}\, ln(w) + E^d_{L/r}\, ln(r) + E^d_P\, ln(P) + v,$$

(14) $$ln\, S_L = A' + E^s_{L/w}\, ln(w) + a_1\, ln(M) + a_2\, ln(WAE/w) + a_3\, ln(1 - U) + v',$$

(15) $$ln\, D_L = ln\, S_L,$$

for which the reduced form is:

(16) $$w = f(r, M, P, WAE/w, 1-U, v'')$$

This was fitted as a three equation model. Fisher fixed-weight price variables were used and compared with non-lagged variables. The other variables were: $(1 - U)$ = percentage of working population employed (a capacity variable), M = working population (numbers of population between the ages of 15 and 65 years), WAE = Australian Average Weekly Earnings,[7] and v, v′, v″ are appropriate random error terms.

[6] The time variable has been previously interpreted as a trend variable representing neutral technological change shifting the input-demand curve. In a recent note, Gupta [12] has demonstrated that, at least for the special case of a Cobb-Douglas function (which is the only one that is Hicks, Solow and Harrod neutral) incorporating augmented technical progress, in the derived reduced form for the input-demand equation the coefficient on a time variable represents the factor *bias* in technological change.

[7] All data series are from the Commonwealth Bureau of Census and Statistics [5]. The numbers of unemployed were those receiving unemployment relief.

In the above specification the sum of the separate elasticities of demand for labour (own-price, $E^{d}_{L/w}$, cross-price, $E^{d}_{L/r}$, and produce-price, E^{d}_{P}) are not constrained to zero as in the single-equation model. Thus the supply of agricultural labour in this model depends on the agricultural wage, the total working population, the slack in the economy, and the relationship between agricultural and non-agricultural wages.

Another formulation was tried which entailed the use of real price variables rather than those in equations (13) and (14). The structural form was as follows:

$$(17)\quad ln\, D_L = A + E^{d}_{L/w}\, ln\, (w/P) + E^{d}_{L/r}\, ln\, (r/P) + b_1 t + v$$

$$(18)\quad ln\, S_L = A' + E^{s}_{L/w}\, ln\, (w) + b_2\, ln\, (WAE/P) + b_3\, ln\, (1 - U) + v'$$

The price variables were all defined as Fisher fixed-weight variables as shown in (12).

All equations in each formulation were over-identified and hence fitted using Two-Stage-Least Squares (2SLS) and Instrumental Variable (IV) regression procedures. The endogenous variables were D_L, S_L, w, WAE/P and r, all others being exogenous.

(ii) *The Capital Models*

The first capital model was specified as follows:

$$(19)\quad ln\, D_K = A + E^{d}_{K/r}\, ln\, (r) + E^{d}_{K/w}\, ln\, (w) + E^{d}_{P}\, ln\, (P) + e,$$

$$(20)\quad ln\, S_K = A' + E^{s}_{K/r}\, ln\, (r) + a_1'\, ln\, (Pw/r) + e',$$

$$(21)\quad ln\, D_K = ln\, S_K$$

for which the reduced form is

$$(22)\quad r = g\, (w, P, P_w/r, e'').$$

The only variables not previously defined are P_W, which is the Wholesale Price Index,[8] and e, e′ and e″, which are appropriate random error terms. Hence, the supply of capital is determined by the price of capital equipment and supplies and some measures of the possibilities for off-farm investment as compared with investment in farming. This capital model was also tested for lagged response to the price variables by the inclusion of fixed-weight price variables as shown above.

The second capital model had the following structural form:

$$(23)\quad ln\, D_K = A + E^{d}_{K/r}\, ln\, (r/P) + E^{d}_{K/w}\, ln\, (w/P) + b_1' t + e$$

$$(24)\quad ln\, S_K = A' + E^{s}_{K/r}\, ln\, (r/P) + b_2' t + e''$$

All price variables were defined in lagged form as in (12) above.

Empirical Results

(i) *Demand and Supply of Total Farm Labour and Capital*

The preferred results for the single-equation regressions on demand for capital and demand for total farm labour are presented in Table 1. The initial regressions had autocorrelation problems (see equations (A), (B), and (C)). After a simple, single-iteration correction for a first-order auto-regressive structure the values of the estimated coefficients were little changed. The corrected equations are shown as (A′), (B′) and (C′). All coefficients are of the hypothesized sign

[8] The source for P_W was the Commonwealth Bureau of Census and Statistics [5].

TABLE 1

Estimation of Elasticities of Demand for Capital and Total Farm Labour—Single Equation Model[a]

Equation	Dependent Variable	Constant	ln F(r/P)	ln F(w/P)	Time	$\bar{R}^{2}$[c]	ρ[b]	d[d]
(A)	ln D_K	4·20	−1·65 (8·41)[e]	1·88 (16·84)		0·98		1·36
(A′)	ln D_K	2·80	−1·50 (6·85)	1·79 (13·45)		0·97	0·32	1·46
(B)	ln D_K	4·25	−0·97 (3·36)	1·16 (4·34)	0·0133 (2·86)	0·99		1·44
(B′)	ln D_K	3·05	−0·90 (2·91)	1·11 (3·78)	0·0099 (2·54)	0·98	0·28	1·64
(C)	ln D_L	4·35	0·73 (4·88)	−0·58 (6·72)		0·81		0·89
(C′)	ln D_L	2·03	0·52 (3·85)	−0·50 (5·49)		0·68	0·56	1·64

[a] *Definitions:*
F(r/P) = Fisher lag on (B.A.E. Equipment and Supplies Price Index/B.A.E. All Products Prices Received Index).
F(w/P) = Fisher lag on (B.A.E. Wage Index/B.A.E. All Products Prices Received Index).
[b] ρ = First-order auto-regression correction factor calculated as $\rho = 1 - \frac{1}{2}d$. Equations were re-run using ρ in a weighted-differencing transformation on the variables.
[c] $\bar{R}^2$ = corrected for degrees of freedom.
[d] d = Durbin-Watson coefficient.
[e] "t" values are in brackets.

and significant. Only the results for the Fisher-lagged price variables are shown. This specification in all cases gave increased $\bar{R}^2$ and more highly significant coefficients. The time variable was significant only for capital. This positive coefficient may be interpreted as indicating capital-using technological bias. The non-significance of the coefficient on the time variable in the labour demand equations indicates neutral technological change for this factor. However, as the labour data were compiled without taking into account changes in quality, the results will be biased against increases in the efficiency of labour.

The regressions estimated by 2SLS for the simultaneous equation models for capital and total farm labour are not presented here. The results were generally unsatisfactory. More satisfactory results were obtained from the IV estimates.

The 2SLS estimates used the transformed Fisher fixed-weight lagged variables. Information on lagged endogenous variables such as r_{t-1}, r_{t-2} and w_{t-1} and w_{t-2} was not used in the estimation. The IV method involved regressing r_t and w_t on all lagged endogenous and exogenous variables and using the predicted values $\hat{r}_t$ and $\hat{w}_t$ in second-stage estimation of each structural equation by OLS. The results of IV estimation on slightly respecified models are shown in Table 2.

Equations (D) and (E) were adversely affected by auto-correlation. A single iteration correction of (D) for auto-correlation results in an equation which is virtually identical to the single equation model (C′) in Table 1. A similar correction on (E), the total labour supply model, results in a reduced coefficient on the off-farm wage variable (WAE/P) as shown in (E′). The zero coefficient on the farm wage variable (w) is in line with the results of Schuh [15], Tyler [17] and others. Total farm labour supply appears unresponsive to agricultural wage rate changes but responds, although in an inelastic fashion, to the 'pull' effect of relative off-farm wages. The effect of off-farm employment conditions on farm labour supply is always substantially negative as reflected in the co-efficients of $ln\ (1 - U)$.

The capital demand equation (F) resembles the single equation form (B) in Table 1. Correcting (F) for auto-correlation would hence result in a similar equation to (B′) in Table 1. The capital supply equations (G) and (G′) have correct signs on the coefficients, but only that on the time variable is significant. This implies that the supply of capital to the agricultural industry grows over time.

(ii) *Demand and Supply of Self-Employed and Hired Labour*

Single and simultaneous equation models were also fitted for two components of total farm labour, namely, self-employed and hired labour. The results are not presented here in full, but are available from the authors.

Briefly, the signs and relative sizes of the coefficients were as expected. The demand for self-employed labour was less elastic than that for hired labour. The cross-elasticity of demand for self-employed labour with respect to the price of capital was also much less elastic than that for hired labour, as would be expected. For both types of labour the 'pull' factors—off-farm wages (WAE/P) and employment conditions $(1 - U)$—were much more important in their effect on labour supply than the 'push' factor (w). This is in accord with results

TABLE 2

Estimation of Elasticities of Demand and Supply for Total Farm Labour and Capital—Simultaneous Equation Model using Instrumental Variables[a]

Equation	Dependent Variable	Constant	$ln\,F\left(\frac{\hat{w}}{P}\right)$	$ln\,F\left(\frac{\hat{r}}{P}\right)$	$ln\,F\left(\frac{\hat{r}}{P_w}\right)$	$ln\,F(w)$	$ln\,F\left(\frac{WAE}{P}\right)$	$ln\,(1-U)$	Time	ρ[b]	d[c]
(D)	$ln\,D_L$	4·33	−0·59 (6·80)[d]	0·76 (4·98)							0·93
(E)	$ln\,S_L$	15·25				0·05 (1·32)	−0·20 (4·92)	−2·10 (1·45)			0·40
(E′)	$ln\,S_L$	2·78				−0·04 (0·42)	−0·14 (3·22)	−1·75 (2·11)		0·80	1·31
(F)	$ln\,D_K$	4·22	1·10 (3·84)	−0·89 (2·87)					0·01 (2·89)		1·62
(G)	$ln\,S_K$	3·45			0·20 (0·64)				0·036 (23·15)		0·82
(G′)	$ln\,S_K$	1·31			0·26 (0·95)				0·015 (11·64)	0·59	1·41

[a] *Definitions:*
F(r/P) = Fisher lag on (B.A.E. Equipment and Supplies Price Index/B.A.E. All Products Prices Received Index).
F(w/P) = Fisher lag on (B.A.E. Wage Index/B.A.E. All Products Prices Received Index).
F(r/P_w) = Fisher lag on (B.A.E. Equipment and Supplies Price Index/A.B.S. Wholesale Price Index).
F(w) = Fisher lag on (B.A.E. Wage Index).
F(WAE/P) = Fisher lag on (Australian Average Weekly Earnings/B.A.E. Wage Index).
(1 − U) = Percentage of Australian working population employed.
The ˆ on top of variables r and w refer to the predicted values of these from the first stage. R^2 values have no real meaning in instrumental variable models and hence were not included.
[b] See footnote [b] in Table 1.
[c] d = Durbin-Watson coefficient.
[d] "t" values are in brackets.

from Schuh [15] and Tyrchniewicz and Schuh [18]. The combined and separate elasticities of these 'pull' factors are much greater compared to the respective 'push' factors for hired labour than for self-employed labour, which is to be expected.

(iii) *Effect of Wage Increases on Agricultural Net Incomes*

The preferred elasticities drawn from the above results are shown in Table 3. For the most part the IV estimates were preferred. With the Fisher-lagged price variables expressed in logarithmic form we can calculate both long-run and short-run price elasticities. The former is the calculated regression co-efficient and the latter is one-half of this.

The value of $E^{d}_{K/w}$ chosen for inclusion in equation (9) was 1·11 in the long-run and 0·56 in the short-run, while the corresponding values of $E^{d}_{L/w}$ for total labour were —0·50 and —0·25. The total labour demand elasticities compare favourably with Griliches' [11] estimates of —0·44 and —0·10, Schuh's [15] of —0·40 and —0·18, and Tyrchniewicz and Schuh's [18] of —1·6 and —0·19.[9] Also, several of the estimates by Liainos [13] are similar to the ones derived here, but the Wallace-Hoover [19] long-run figure of —1·43 and that of Bauer [1] of —1·48 are somewhat larger. This may be expected as they both employed cross-sectional data in their analyses while all the

TABLE 3

Preferred Estimates of Labour and Capital Demand and Supply Elasticities

Item	Own Price Elasticity[a]	Cross Price Elasticity[b]
Total Labour:[c]		
Demand	−0·50	0·76
Supply	0·04	n.a.[d]
Total Capital:[c]		
Demand	−0·90	1·11
Supply	0·26	n.a.[d]
Self-employed Labour:[e]		
Demand	−0·38	0·18
Supply	0·18	n.a.[d]
Hired Labour:[e]		
Demand	−0·58	0·75
Supply	0·03	n.a.[d]

[a] These are the long-run estimates of elasticities. The short-run elasticities are one-half of these due to the form of the Fixed-weight lag structure used to define the price variables.
[b] These refer to the elasticity of demand for the input with respect to the price of its counterpart, e.g. total labour with respect to the price of capital.
[c] These were all calculated using Young's [20] data.
[d] n.a. means these were not estimated in any of the models.
[e] These are an amalgam of the elasticities derived in the various equations tried. For the most part the elasticities derived when Young's data were used were lower in absolute terms than those derived using Powell's data.

[9] Tyrchniewicz and Schuh [18] give separate estimates for hired, operator and family labour. To obtain an estimate of demand elasticity of total labour from these, the component short-run elasticities were given weights of 0·25, 0·55 and 0·20 respectively to derive the short-run figure of —0·19. No long-run elasticity was derived by them for operator labour so the long-run estimate of —1·6 is an over-estimate of the total demand elasticity. It is a weighted average of the hired and family components only, which are more elastic than that of the operator.

other studies used time series data. The derivation of the values for the other terms in equation (9) of the text has been described earlier.

The values for wL, rK and N for the years 1965-6 to 1968-9 are given in Table 4.[10] An estimate of the price elasticity of demand for Australian agricultural production was made by taking various estimates and guesses about the elasticity of demand for individual products and weighting these by the proportion which each industry contributed to gross value of farm production in the three-year period ending 1968-9. The value for η estimated in this way is approximately $-1 \cdot 5$. This value is, of course, heavily dependent on the elasticity of demand for wool, which was taken to be $-3 \cdot 0$. In this three-year period wool contributed 21 per cent of gross value of rural production. In 1967-8, a drought year, the proportion of agricultural output sold on the domestic market was increased and this would tend to make overall demand more inelastic. For such reasons we decided to examine the sensitivity of E_N with respect to η.

The values of E_N for values of η ranging from $-0 \cdot 5$ to $-2 \cdot 0$ are presented in Table 4. These results show that in 1968-9 terms, with a 14 per cent increase in wage costs and with $\eta = -1 \cdot 5$, the return to management and risk is reduced by $43 \cdot 7$ per cent in the long-run and in the short-run by $29 \cdot 5$ per cent. In the long-run as η approaches $-\infty$, E_N approaches the value of wL/N, as can be seen from examination of equation (9). In 'good' years, e.g. 1966-7, the effect of wage increases on N, in percentage terms, would be less than in years when the return to management and risk is smaller. The calculated long-run values of E_N for the average of the period 1965-6 to 1967-8 for values of η of $-0 \cdot 5$, $-1 \cdot 0$, $-1 \cdot 5$ and $-2 \cdot 0$ are $-7 \cdot 36$, $-4 \cdot 30$, $-3 \cdot 27$ and $-2 \cdot 77$ respectively. The respective short-run elasticities are $-4 \cdot 33$, $-2 \cdot 79$, $-2 \cdot 27$ and $-2 \cdot 01$.

The impact of a rise in wages on the farm operator is twofold—the rise in the opportunity cost of his own labour, and the change in the return to management and risk. We can also calculate the effect of a rise in wages which is restricted to the hired agricultural labour force on net farm income (N′) of self-employed labour (owners, lessees, sharefarmers). Some may consider this to be more realistic than allowing for the owner-operator's wage in calculating the return to management and risk (N). E_N' was calculated by inserting the elasticity of demand for hired labour in equation (9) in place of the total labour elasticity and using N′ instead of N.[11] The derived elasticities of net farm income with respect to wages are shown in Table 5.

Comparing Tables 4 and 5 it is seen that the elasticities of net farm incomes in all years except 1967-68 are just over one-half the corresponding elasticities of net incomes. In 1967-68 the former are about

[10] The size of E_N is relatively insensitive to changes in the elasticities of production. Hence the Cobb-Douglas assumption that these elasticities of production equal the relative shares does not appear critical. Indeed as η approaches -1 in value the elasticities of production do not affect E_N

[11] The hired labour demand elasticity of —0.58 in the long-run compares with Schuh's [15] long-run value of —0.40 and that of Tyrchniewicz and Schuh [18] of —0.49. Liainos [13] derived much larger hired labour demand elasticities for the Southern U.S. Maybe interregional migration biases the Liainos estimates upwards compared to the more aggregative elasticities derived here and in the above references.

TABLE 4

Values of N, wL, rK and E_N for the Period 1965–6 *to* 1968–9

Year	Gross Value of Farm Production[a]	Net Farm Income (N′)[b]	Opportunity Cost of Operators' Labour[c]	Net Opportunity Cost of Capital[d]	Net Income (N)[e]	$\frac{N}{PQ}$	$\frac{wL}{PQ}$	$\frac{rK}{PQ}$	Long-run Value of E_N for η values of:				Short-run Value of E_N for η values of:			
									−0·5	−1·0	−1·5	−2·0	−0·5	−1·0	−1·5	−2·0
	($m)	($m)	($m)	($m)	($m)											
1965–6	3,347	1,112	406	97	609	·182	·227	·591	−7·22	−4·23	−3·24	−2·75	−4·27	−2·75	−2·27	−2·00
1966–7	3,828	1,409	431	100	878	·229	·204	·567	−5·50	−3·19	−2·43	−2·06	−3·24	−2·05	−1·66	−1·47
1967–8[f]	3,345	869	443	87	339	·101	·234	·665	−14·62	−8·47	−6·42	−5·41	−8·53	−5·42	−4·36	−3·87
1968–9	3,956	1,287	461	84	742	·188	·211	·601	−7·10	−4·11	−3·12	−2·63	−4·14	−2·63	−2·11	−1·85

[a] *Source:* Commonwealth Bureau of Census and Statistics [3].
[b] *Source:* Glau [10].
[c] Using Commonwealth Basic Wage from Commonwealth Bureau of Census and Statistics [5].
[d] Using Opportunity Cost of Capital at 6·5% minus interest paid on borrowed funds at 6·5%.
[e] N = Net Farm Income—(net opportunity cost of capital + opportunity cost of operators' labour).
[f] 1967–8 was a drought year.

TABLE 5

Values of E_N' for the Period 1965-66 to 1968-69

Year	Long-run Value of E_N' for η values of:				Short-run Value of E_N' for η values of:			
	−0·5	−1·0	−1·5	−2·0	−0·5	−1·0	−1·5	−2·0
1965–66	−3·84	−2·26	−1·74	−1·48	−2·28	−1·48	−1·21	−1·08
1966–67	−3·33	−1·94	−1·48	−1·25	−1·84	−1·25	−1·02	−0·91
1967–68	−5·54	−3·22	−2·44	−2·07	−3·06	−2·08	−1·68	−1·49
1968–69	−4·00	−2·32	−1·77	−1·49	−2·21	−1·49	−1·21	−1·08

40 per cent of the latter. The relative sizes of the two groups of elasticities are as expected. E_N allows the opportunity cost of the operator's labour to rise with the increase in wages, thus reducing net income, whereas $E_{N'}$ does not.

In 1968-69 there were an estimated 242,000 self-employed operators on farms in Australia.[12] From Table 4 this means each male equivalent earned $3,070 as a return to management and risk, or a $4,970 return to their own labour, management and risk. With a 14 per cent increase in wages in rural industries the number of self-employed farmers could fall by approximately 5·32 per cent to 229,000. This is derived by using —0·38 as the long-run demand elasticity for self-employed labour from Table 3. The total net return to management and risk may fall by 43·7 per cent to approximately $418m.[13] Hence the impact of a 14 per cent increase in wages in rural industries in the long-run could be to move approximately 12,900 self-employed farmers off the land. It would also depress the net return to management and risk of those remaining from $3,070 per head to approximately $1,820, a reduction of 40 per cent. These self-employed farmers remaining gain (implicitly) an increased opportunity cost (return) from the increase in wages. Hence the average labour, management and risk return to self-employed farmers could change from $4,970 to $3,998 per head—a 20 per cent reduction. The estimated reduction in the number of hired workers is 8 per cent or about 12,000, assuming their elasticity of demand is —0·58 in the long-run.

Using data for 1968-69, total net farm income could fall in the long-run by 25 per cent to $968m., after a 14 per cent rural wage increase.[14] The amount per farmer may fall by 20 per cent, from $5,320 to $4,230. In the short-run total net farm income would fall some 17 per cent to $1,068m., involving a fall in net farm income per farmer of 12 per cent to $4,661.

It would be expected that the impact of a reduced working week would differ among farms or regions having different labour/capital ratios. An idea of the likely effect of relative labour intensity on E_N can be obtained by taking the partial differential of equation (9) with respect to L. This partial differential will be negative when $|\eta| > E^d_{L/w}$, positive when

12 Estimated by the authors from data kindly provided by R. Powell, University of New England.

13 This assumes E_N = —3.12 for a η value of —1.5 and the level of farm income that occurred in 1968-69.

14 This assumes E_N' = —1.77 for a η value of —1.5.

$|\eta| < E^{d}_{L/w}$ and zero if $|\eta| = E^{d}_{L/w}$. The inference to be drawn here is that relatively labour intensive farms or regions will have net incomes reduced more after introduction of a shorter working week if they face a more elastic product demand curve relative to their labour demand curve. It suggests that industries such as canned fruits, fresh apples and pears, dried vine fruits and some vegetable products could fit into the category of those who may expect to have a lower (algebraic) E_N than the average. As a result, the increased wage costs may reduce their net incomes much more than other industries.

The condition for E_N to be less than zero is that:[15]

$$\frac{rK}{wL} > \frac{\eta - E^{d}_{L/w}}{E^{d}_{K/w}} \tag{25}$$

If $|\eta| \geqslant E^{d}_{L/w}$, (25) will always be true. If $|\eta| < E^{d}_{L/w}$, it may be true if capital's share is large relative to labour's share. Hence, the above four industry groups, besides having a smaller E_N (algebraically) due to their relatively high labour/capital ratios, most probably also have negative E_N values. Even relatively capital intensive industries such as intensive poultry and pigs, woolgrowing, cereal grains and beef may have a negative E_N.

Conclusions

It appears that the long-run elasticity of demand for total farm labour in Australia with respect to real farm wage rates is around —0·5. The demand for hired labour is more elastic at —0·58 than the demand for self-employed labour of —0·38.

The long-run cross-elasticities of demand for total, self-employed and hired farm labour with respect to the real price of capital equipment and supplies are estimated to be 0·76, 0·18 and 0·75 respectively. Farmers are much more inclined to substitute hired labour for capital than to shift out of farming when the price of capital rises relative to the price of labour.

The total and hired farm labour supplies appear unresponsive to farm wage rate changes but respond, though inelastically, to the 'pull' effect of relative off-farm wages and elastically to buoyant labour employment conditions in the urban areas. Self-employed labour supply is not as responsive to the buoyancy of urban labour market conditions as are total and hired labour supplies. However, it is more responsive to the level of the farm wage rate than the latter two.

The long-run demand for total capital in Australian rural industries seems to be slightly inelastic at about —0·90 with respect to the real price of equipment and supplies. However, the cross-elasticity of demand for capital with respect to real farm wage rates appears to be elastic at 1·11 in the long-run.

It appears the most likely effect of a 14 per cent wage rate increase in Australian rural industries may be, in 1968-69 terms, to reduce the aggregate net return to entrepreneurial management and risk by approximately 44 per cent in the long-run and 30 per cent in the short-run. Aggregate net farm incomes might fall by about 25 per cent in the

[15] This result only holds in the two-factor case where we assume $E^{d}_{K/w}$ is positive. The whole analysis could be easily extended to the i factor case ($i = 1, 2, \ldots . n$). As we are only concerned with labour and capital, the two-factor model is employed here.

long-run and 17 per cent in the short-run. These figures assume a total elasticity of demand for Australian agricultural output of —1·5.

The number of self-employed farmers may fall by about 5 per cent, or approximately 13,000 persons, after complete adjustment to a 14 per cent wage increase. The number of hired farm labourers required could fall by an estimated 8 per cent or by 12,000 persons.

The resultant effect of the aggregate income and resource adjustments noted above is likely to be to depress the net return to management and risk of those self-employed farmers remaining in agriculture from $3,070 per head to approximately $1,820 in the longer-run. This is a 40 per cent reduction. Corresponding figures for net farm income per head are $5,320 and $4,230, or a 20 per cent reduction.

In conclusion, it should be pointed out that in this paper a number of assumptions have been made. The first was that the price of capital goods remains constant. In the longer-run there would be a simultaneity problem in that a general increase in wage rates would subsequently affect the price of capital goods purchased by farmers. As the price of capital goods rose, the degree of substitution of capital for labour would decline below the levels specified in the study. However, the combined effect of a rise in both the price of labour and eventually that of capital, would be to reduce agricultural net incomes more. Net incomes per self-employed farmer after these effects had worked themselves out would be difficult to determine. The result hinges on the extent of the rise in the price of farm capital goods caused by an economy-wide introduction of a shorter working week. The size of the rise may be dampened by the leverage effect of imports not subject to the same increase in wages, although if unused tariffs are in fact of the magnitude some believe, the countervailing effect of imports would be reduced. Moreover, in a general equilibrium context, the reduced returns on risk capital and management would mean an additional outflow of both capital and management in order to regain parity of returns with other sectors in the economy.

Another aspect of the problem has not been mentioned. An overall money wage rise will increase domestic money income and hence the demand for agricultural products. However, this effect may be ignored as the income elasticity of demand for agricultural products is most likely to be fairly small.

For the above reasons the elasticity of net income estimates and the ancillary measures should be regarded as strictly partial equilibrium values. In particular, the question of the pace and direction which technological change would take subsequent to introduction of a shorter working week has not been examined at all here. In general, it would be expected to offset the effects we have estimated. This is a most important aspect of the problem and requires investigation.

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